UNIVERSITY OF SASKATCHEWAN

College of Engineering

G.E. 120.3

Introduction to Engineering II

FINAL EXAMINATION #1

February 27th, 2006

7:00 PM - 9:00 PM

STUDENT NAME: _____

STUDENT NUMBER: _____

LECTURE SECTION:

☐	L02	Tu-Th	11:30 – 1:00	Prof. B. Daku
☐	L04	Tu-Th	1:00 – 2:30	Prof. D. Chen
☐	L06	Tu-Th	2:30 – 4:00	Prof. P. LePouder/Prof. T. Fonstad

Question 1	/ 15
Question 2	/ 15
Question 3	/ 10
Question 4	/ 15
Question 5	/ 10
Question 6	/ 15
TOTAL	/ 80

GENERAL INSTRUCTIONS FOR THE QUESTIONS

1) **NO** textbooks, **NO** notes, **NO** assignments, and **NO** laboratory logbooks/reports.
2) **NO calculators allowed**.
3) Neatness counts. Please ensure your paper is readable.
4) Some questions contain special instructions. Please ensure that you read these carefully.
5) Not all questions are of the same difficulty and value. Consider this when allocating time for the solution.
6) *IF A QUESTION PROVES TO BE TOO HARD FOR YOU TO SOLVE, GO ON TO ANOTHER QUESTION! RETURN TO THE TROUBLESOME QUESTION WHEN TIME PERMITS.*

PLEASE NOTE

ALL parts of the examination paper MUST be handed in before leaving.

Please check that your examination paper contains x pages TOTAL.

QUESTION #1

MARKS: 15 (1.5 + 1 + 4 + 1.5 + [0.5x14])

SHORT ANSWER

1. What are the three main areas of study within the discipline of Agricultural and Bioresource Engineering?

   _____ .

   _____ .

   _____ .

2. What was the condition/constraint that had to be met in the final “design” question in the EP lab involving a rocket with a 1000kg payload.

   _____

3. List four criteria that were to be used to evaluate the designs of the roof top water collection systems in the EWB lab.

   _____

   _____

   _____

   _____

4. In the Mechanical Engineering presentation, they mentioned 5 branches of Mechanical Engineering. Give 3 of them.

   _____

   _____

   _____

5. For the following diagram, fill in the blanks on the left hand column and list the corresponding design steps in the right hand column (not all blanks in the right hand column will have an answer) :

   Generally _____ i)_____
   ii)_____
   iii)_____
   iv)_____

   Specificallly _____ i)_____
   ii)_____
   iii)_____
   iv)_____

   Generally _____ i)_____
   ii)_____
   iii)_____
   iv)_____

   Specificallly _____ i)_____
   ii)_____
   iii)_____
   iv)_____

QUESTION # 2

MARKS: 15 (2 + 4 + 2 + 3 + 2 + 2)

SHORT ANSWER

1. Solve the following equation for the variable x.

$$\begin{vmatrix} x & x+1 \\ -1 & x-2 \end{vmatrix} = 7$$

2. Evaluate each of the following determinants.

a) $\begin{vmatrix} 1 & 0 & 1 & 2 \\ 9 & 2 & 8 & 4 \\ 8 & 0 & 8 & 16 \\ 3 & 0 & 9 & 2 \end{vmatrix}$

b) $\begin{vmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{vmatrix}$

3. Determine the following operations are TRUE or FALSE, where A, B, C, are matrices, K is a scalar, and "det( )" denotes the operation of determinant.

___a) $(A \cdot B)^{\mathrm{T}} = A^{\mathrm{T}} \cdot B^{\mathrm{T}}$
___b) $A \cdot (B \cdot C) = (A \cdot B) \cdot C$
___c) $A \cdot B + A \cdot C = A \cdot (B + C)$
___d) $\det(A) = \det(A^{\mathrm{T}})$
___e) $K \cdot \det(A) = \det(K \cdot A)$
___f) $\det(A \cdot B) = \det(A) \cdot \det(B)$

4. Using Cramer's rules, solve for x_1 and x_2 for the following equations

$$\begin{aligned} 2x_1 + x_2 &= 12 \\ 3x_1 + 2x_2 &= 23 \end{aligned}$$

5. Do the following equations have one unique solution? why or why not? **DO NOT SOLVE.**

$$\begin{aligned} 3x_1 + x_2 + x_3 &= 0 \\ 5x_1 + 3x_2 + x_3 &= 0 \\ 2x_1 + 2x_2 &= 9 \end{aligned}$$

6. Determine the order, the rank, and the trace of the coefficient matrix of the system of equations given in 5.

Order _____ Rank _____ Trace _____

Student Name: _____Student Number: _____

QUESTION # 3

MARKS: 10 (3 + 3 + 3 + 1)

SHORT ANSWER

The elastic deformation of a membrane in the plane is defined by the transformation $y = Ax$, where

$$A = \begin{bmatrix} 4 & \sqrt{3} \\ \sqrt{3} & 2 \end{bmatrix}, \; x = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}, \; y = \begin{bmatrix} y_1 \\ y_2 \end{bmatrix}.$$

1. (3 marks) Find the eigenvalues of A.

2. (3 marks) Find the eigenvector for each eigenvalue of A.

3. (3 marks) Sketch the eigenvector directions in the (x_1, x_2) plane. Clearly label the angles between the eigenvectors and the positive x_1 axis. Indicate a point on the plane (not including the origin) that remains fixed after applying the transformation A.

4. (1 mark) It is known that the elastic membrane will break when stretched beyond four times its original dimension in any direction.
   a. Will the deformation specified by A cause the membrane to fail?

   b. How do you know (ie. Why or Why not)?

QUESTION #4

MARKS: 15 (10 + 3 + 2)

Student Name: _____Student Number: _____

A system of three equations is given as follows:

$$5x_1 + 2x_2 + 4x_3 = 1$$
$$2x_1 + x_2 + 2x_3 = 1$$
$$4x_1 + 2x_2 + 3x_3 = 1$$

1. Find the inverse of the coefficient matrix using the determinant and adjoint matrix.

2. Solve the system of equations using the inverse of matrix found in “1.”

3. Check your answer obtained in “2.”

Student Name: _____Student Number: _____

QUESTION #5

MARKS: 10 (5 + 2 + 3)

A system of three linear equations is given as:

$$2x + 3z + 3y = 2$$
$$5y + 7z = 2$$
$$8z + 6x + 9y = 5$$

1. Find the inverse of the coefficient matrix using Gauss-Jordan method.

2. Solve the systems of equations using the inverse matrix method (using the results in “1.”)

3. Write all of the MATLAB commands required to solve the systems using inverse matrix method.

Student Name: _____Student Number: _____

QUESTION #6
MARKS: 15

There are four containers of acid solutions, the first (a) is a 20% acid solution, the second (b) is 40% and the third (c) is 60% and the last (d) is 80%. Mixing all of the containers produces 100 L of a 41% acid solution. It is known that if the concentration of the solution in the first container (a) were 80% and the concentration of the solution in the last container (d) were 20% and you mixed all the containers, the result would be 100 L of a 56% acid solution. It is also known that if the containers of 60% and 80% solution are combined the result is a 70% acid solution. **How much of the 20%, 40%, 60% and 80% solutions are in the containers? Solve the system of equations using Gaussian elimination.** (Hint: the quantity of acid is equal to the concentration in decimal form multiplied by the volume)